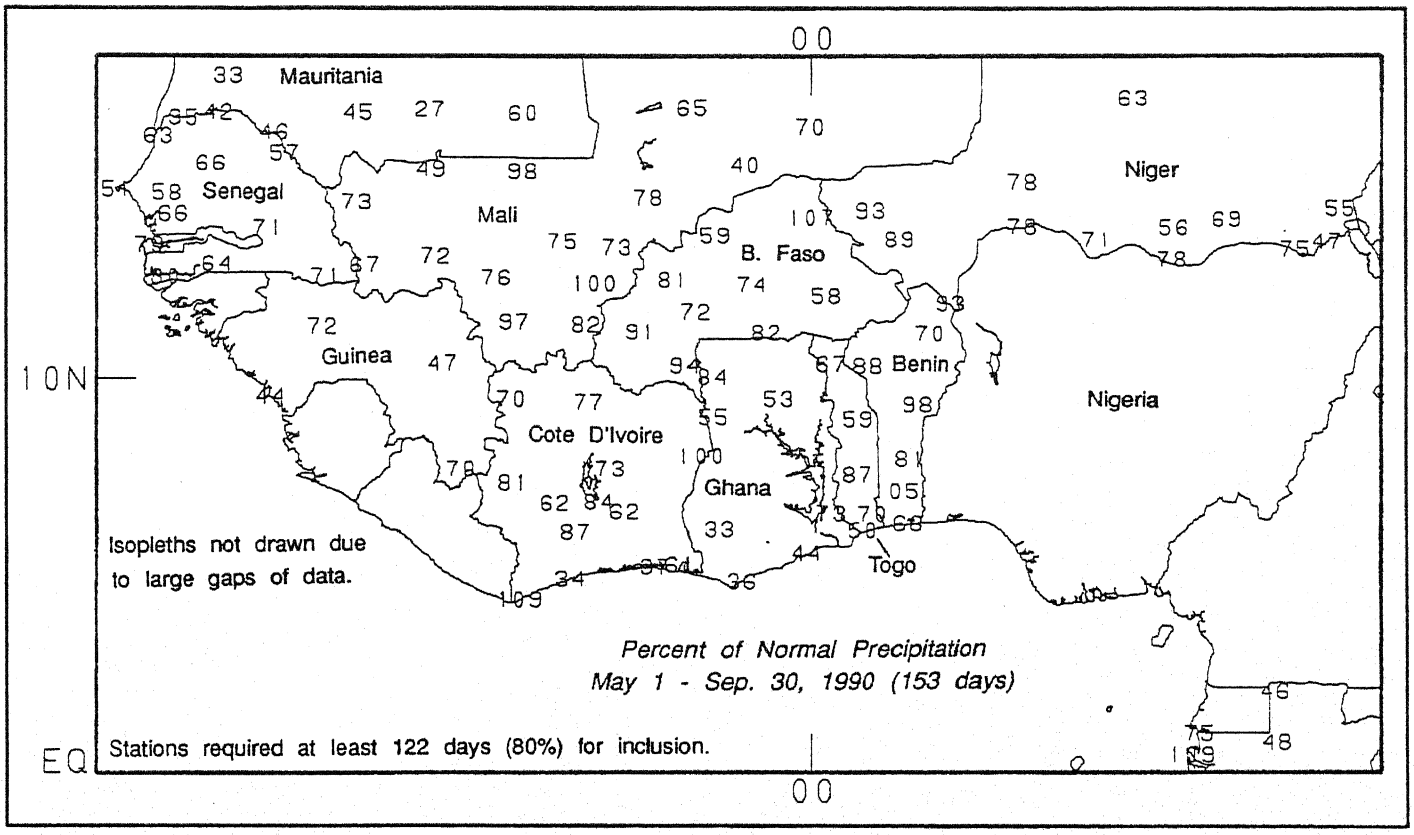
CLIMATE ANALYSIS CENTER

CONTAINS:
REVIEW OF THE 1990 INDIAN MONSOON AND AFRICAN SAHEL RAINY SEASON

WEEKLY CLIMATE BULLETIN

No. 90/43 Washington, DC October 27, 1990



The 1990 African Sahel rainy season (May – September) was generally below normal, with most station's totals being less than in 1988 and 1989. A late start to and an early withdrawal of the summer rains resulted in approximately 75% of the normal seasonal precipitation across most of the western Sahel, and less than half the usual rainfall in parts of east–central Sudan and northern Ethiopia. For further details on the 1990 Sahel rainy season and the Indian Monsoon, refer to pages 9 – 14.

UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE–NATIONAL METEOROLOGICAL CENTER
CLIMATE ANALYSIS CENTER

WEEKLY CLIMATE BULLETIN

This Bulletin is issued weekly by the Climate Analysis Center and is designed to indicate, in a brief concise format, current surface climatic conditions in the United States and around the world. The Bulletin contains:

- *Highlights of major climatic events and anomalies.*
- *U.S. climatic conditions for the previous week.*
- *U.S. apparent temperatures (summer) or wind chill (winter).*
- *U.S. cooling degree days (summer) or heating degree days (winter).*
- *Global two–week temperature anomalies.*
- *Global four–week precipitation anomalies.*
- *Global monthly temperature and precipitation anomalies.*
- *Global three–month precipitation anomalies (once a month).*
- *Global twelve–month precipitation anomalies (every three months).*
- *Global three–month temperature anomalies for winter and summer seasons.*
- *Special climate summaries, explanations, etc. (as appropriate).*

Most analyses contained in this Bulletin are based on preliminary, unchecked data received at the Climate Analysis Center via the Global Telecommunications System. Similar analyses based on final, checked data are likely to differ to some extent from those presented here.

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GLOBAL CLIMATE HIGHLIGHTS

MAJOR CLIMATIC EVENTS AND ANOMALIES AS OF OCTOBER 27, 1990

1. The Southeastern U.S. and Bahamas:

COPIOUS RAINFALL BRINGS CONTINUED RELIEF.

Two strong storm systems dumped 65–155 mm of precipitation on northern Georgia and the Carolinas, producing widespread minor flooding and blanketing the highest elevations of the southern Appalachians under a foot of snow. Generous rains (25–100 mm) also soaked the immediate central Gulf, eastern Georgia, and northeastern Florida coasts as well as central Georgia and northeastern Alabama. Lesser amounts (10–35 mm) dampened most of Florida, Georgia, Alabama, Mississippi, and the Bahamas, although isolated totals up to 55 mm were measured in southeastern Florida and the southern Bahamas. Daily rainfall amounts reached 114 mm in isolated thunderstorms across extreme western Florida. Since mid–September, surplus rain has fallen along much of the Eastern Seaboard, but some deficits (50–100 mm) remained along the central Gulf Coast and in Florida. Isolated portions of the Bahamas have been extremely dry, with deficits ranging upward to 234 mm [Ending after 30 weeks].

2. Eastern United States:

TEMPERATURES RETURN TO SEASONABLE LEVELS.

An invasion of chilly, Canadian air brought the recent warm spell to an end and the season's first freeze to parts of the central and eastern U.S. [Ended after 4 weeks].

3. Continental Europe and North–Central Africa:

COOLER WEATHER INVADES CENTRAL AND SOUTHEASTERN SECTIONS.

Summer–like weather persisted across north–central Africa as temperatures averaged 4°C to 7°C above normal. Unseasonably high temperatures, with departures ranging from +2°C to +4°C, also plagued western and northern Scandinavia, France, and the Benelux countries. In contrast, sharply cooler air combined with persistent cloud cover and precipitation to produce temperatures 2°C to 5°C below normal across southern Scandinavia, east–central continental Europe, and the Balkans [Ending after 6 weeks].

4. Western Europe:

MODERATE RAINS RELIEVE SHORT–TERM DRYNESS.

Light rain (10–30 mm) moistened most of central and northern France while scattered areas across northwestern, southern, and eastern France received 40–70 mm. Although long–term precipitation shortfalls persist throughout much of Europe, only isolated portions of France reported deficits in excess of 50 mm since mid–September [Ended after 26 weeks].

5. Central and Western Sahel:

WARM WEATHER CONTINUES.

Weekly departures of +2°C to +3°C were again recorded throughout the region, with the largest departures afflicting southern and western sections [11 weeks].

6. Southern India and Sri Lanka

LATE–SEASON RAINS DRENCH REGION.

Two weeks of inundating rainfall produced widespread flooding that killed nearly four dozen individuals, according to press reports. Up to 283 mm have soaked the region since mid–October, with 100–252 mm measured last week. Daily totals reached 99 mm, and some locations have accumulated more than 163 mm of excess precipitation during the period [2 weeks].

7. Southeast Asia:

DRIER WEATHER ENGENDERS RECOVERY FROM RECENT TROPICAL STORMS.

Only 30–70 mm of rain fell on most of Vietnam and central Thailand, although isolated coastal locations in Vietnam were again inundated by up to 191 mm of rain. Flooding continued to be a problem, however, as water from previous rains filtered into streams and rivers. According to press reports, nearly 6500 square kilometers of land were submerged in Thailand, where more than two dozen individuals drowned. At least 110,000 Vietnamese houses were underwater at one point, and unofficial reports indicate that nearly 800 mm of rain fell on some areas since October 1 [Ending after 4 weeks].

8. Northeastern China and North Korea:

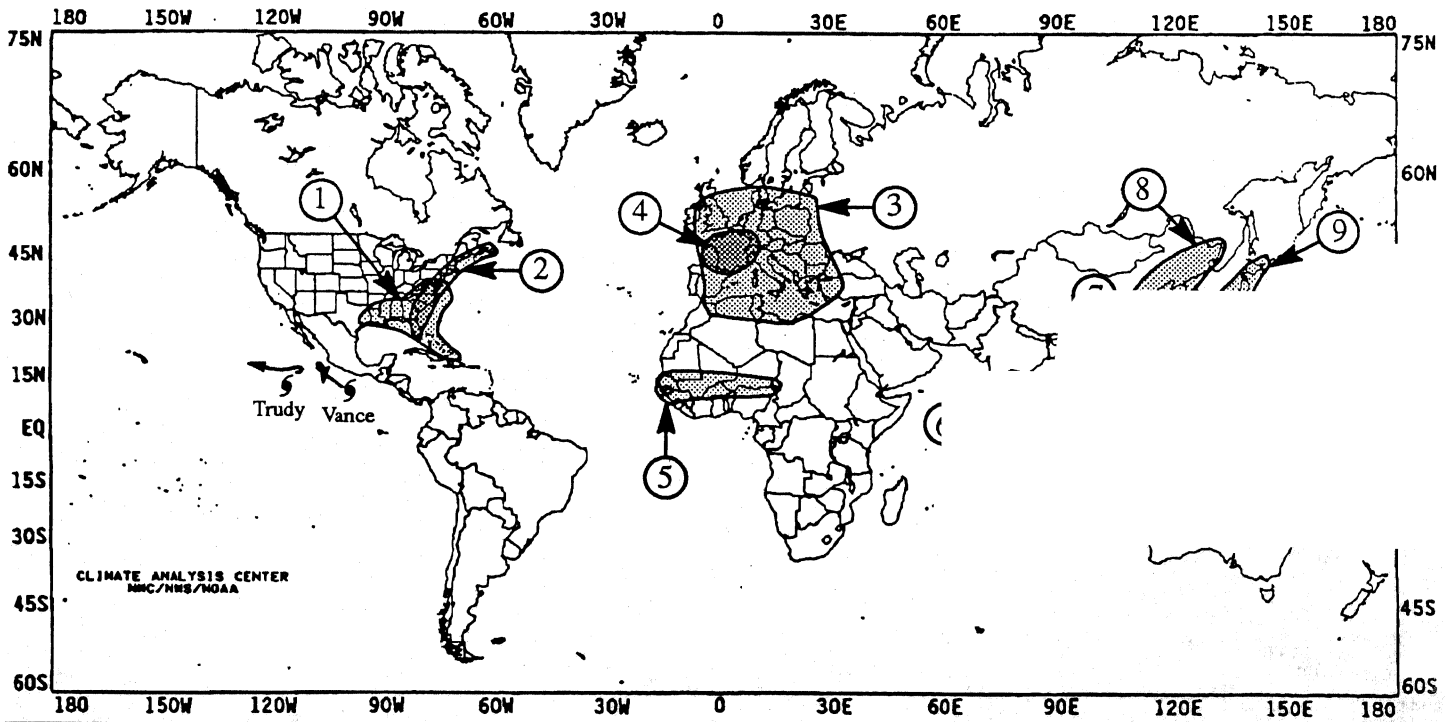
EXCEPTIONALLY DRY WEATHER DEVELOPS.

After being soaked by inundating rains earlier this year, four successive weeks have passed with little or no precipitation. Only a few scattered locations received 15–35 mm of rain from light showers last week [4 weeks].

9. Japan:

WARMTH AND WETNESS DIMINISH SLIGHTLY.

Only 10–20 mm fell on the extreme southern and northern ends of the island chain while 30–70 mm moistened the northern three–quarters of Honshu and southern sections of Hokkaido. Heavy rains (90–135 mm), however, inundated the northeastern and southeastern corners of Honshu. Despite the recent decline in rainfall totals, large precipitation surpluses persist in many areas. Since mid–September, surpluses of 400–660 mm have accumulated across portions of south–central Honshu [Ending after 6 weeks]. Temperatures were also lower across the nation, but most locations remained slightly above normal with departures from +1°C to +3°C [Ending after 11 weeks].



EXPLANATION

TEXT: Approximate duration of anomalies is in brackets. Precipitation amounts and temperature departures are this week's values.

MAP: Approximate locations of major anomalies and episodic events are shown. See other maps in this Bulletin for current two week temperature anomalies, four week precipitation anomalies, long–term anomalies, and other details.

UNITED STATES WEEKLY CLIMATE HIGHLIGHTS

FOR THE WEEK OF OCTOBER 21 – 27, 1990

Heavy October rains have soaked much of the East during two of the past three weeks. Early in the month, moisture from the remnants of Tropical Storms Klaus and Marco streamed northward along a cold front that stalled along the Appalachians, producing copious rains from Florida northward to Maine. This week, two intense low pressure centers developed along a slow–moving cold front and moved northeastward up the Atlantic Coast. Many locations in the East measured over two inches of rain, with amounts exceeding 6 inches across portions of the Carolinas (Figure 1). The heavy rains produced widespread flooding from Georgia to Maine. Bridges were washed out in parts of the western Carolinas, and evacuations were necessary. More than two dozen roads were closed in the metropolitan Washington, D.C. area as heavy rains deluged the region on Tuesday. The heavy rains moved into New England later in the week, producing flooding as far north as Caribou, ME. Much of the East received more rain this week than what normally falls during the entire month, and several stations set new October rainfall records. High winds also accompanied the rains. Winds reached hurricane strength along parts of the Atlantic Coast, and South Island near Norfolk, VA recorded gusts up to 92 mph. Along the Outer Banks of North Carolina, high winds ripped a dredge from its moorings and pushed it into the Herbert C. Bonner Bridge, knocking out a 250 foot section of the bridge that stranded many residents. Farther west, high winds and heavy rain also pounded parts of the Pacific Northwest. Unseasonably cold air invaded much of the Mississippi Valley and southern Great Plains, producing record low temperatures in Texas. Much of the East received the coldest air of the Fall as frosts were common. In sharp contrast, portions of the Great Basin and northern Rockies basked in record warmth. Temperatures soared into the eighties as far north as Montana, producing record highs from Idaho to Nebraska. In California, Santa Ana winds fanned a fire in the San Bernardino National Forest, charring 500 acres. A strong storm system produced near–blizzard conditions across northern Alaska with wind chills near –40°F. Meanwhile, the southern part of the state was buffeted by heavy rains and high winds as Ketchikan reported gusts up to 90 mph.

The first half of the week began with a cold front stretched from the upper Midwest southward to the lower Mississippi Valley. Strong thunderstorms developed along the southern portion of the front, dumping up to 3 inches of rain across parts of the lower Mississippi Valley. A low pressure center developed in the Southeast and moved northward along the front, dropping heavy rains on much of the area. Strong thunderstorms produced hail across parts of central and eastern North Carolina and a twister was reported near Fayettville. Much colder air settled in behind the front across the eastern half of the country where lows dropped into the thirties. The cold air moved over the warm, moist ground, producing thick fog across portions of the Ohio Valley. In sharp contrast, record warmth was reported over southern Florida and parts of the West. A frontal system moving through the Pacific Northwest battered coastal Washington and Oregon with rain and high winds.

During the last half of the week, a second storm system formed south of Cape Hatteras, NC while an upper–level disturbance moved across western North Carolina, dumping the season's first snowfall on the higher elevations of the Carolina Appalachians. Mt. Mitchell, NC measured nearly a foot of snow. The two systems eventually merged off the Carolina coast, creating an intense storm that brought hurricane–force winds along the coast and gale–force winds inland, causing property damages and power outrages. The rest of the nation was predominantly dry as high pressure dominated the western two–thirds of the country. Cold air pushed into Florida, producing record cold across the southern part of the state. Unseasonably warm weather, however, prevailed across the western half of the country where numerous record highs were observed from Arizona to North Dakota. Strong winds continued to pound parts of southern Alaska as an intense storm moved across the Gulf of Alaska.

According to the River Forecast Centers, the greatest weekly totals (more than 3 inches) fell on the lower Mississippi Valley, southern and middle Atlantic Coast states, and northern New England (Table 1). Scattered heavy amounts were observed across the Pacific Northwest and southern Alaska. Light to moderate precipitation was recorded in the Pacific Northwest, northern Rockies, southern Great Plains, and throughout most of the country east of the Mississippi. Little or no precipitation was observed across the remainder of the West and Plains, in the upper Midwest, central Great Lakes region, and lower Missouri Valley.

A strong ridge of high pressure brought unseasonably warm weather to much of the nation west of the Rockies. Weekly departures between +5°F and +10°F were reported in parts of the Southwest and Great Basin (Table 2) where highs soared into the eighties and nineties. Slightly above normal temperatures occurred across the remainder of the West, in northern and central Plains, and along the extreme Atlantic and southern Alaskan Coasts.

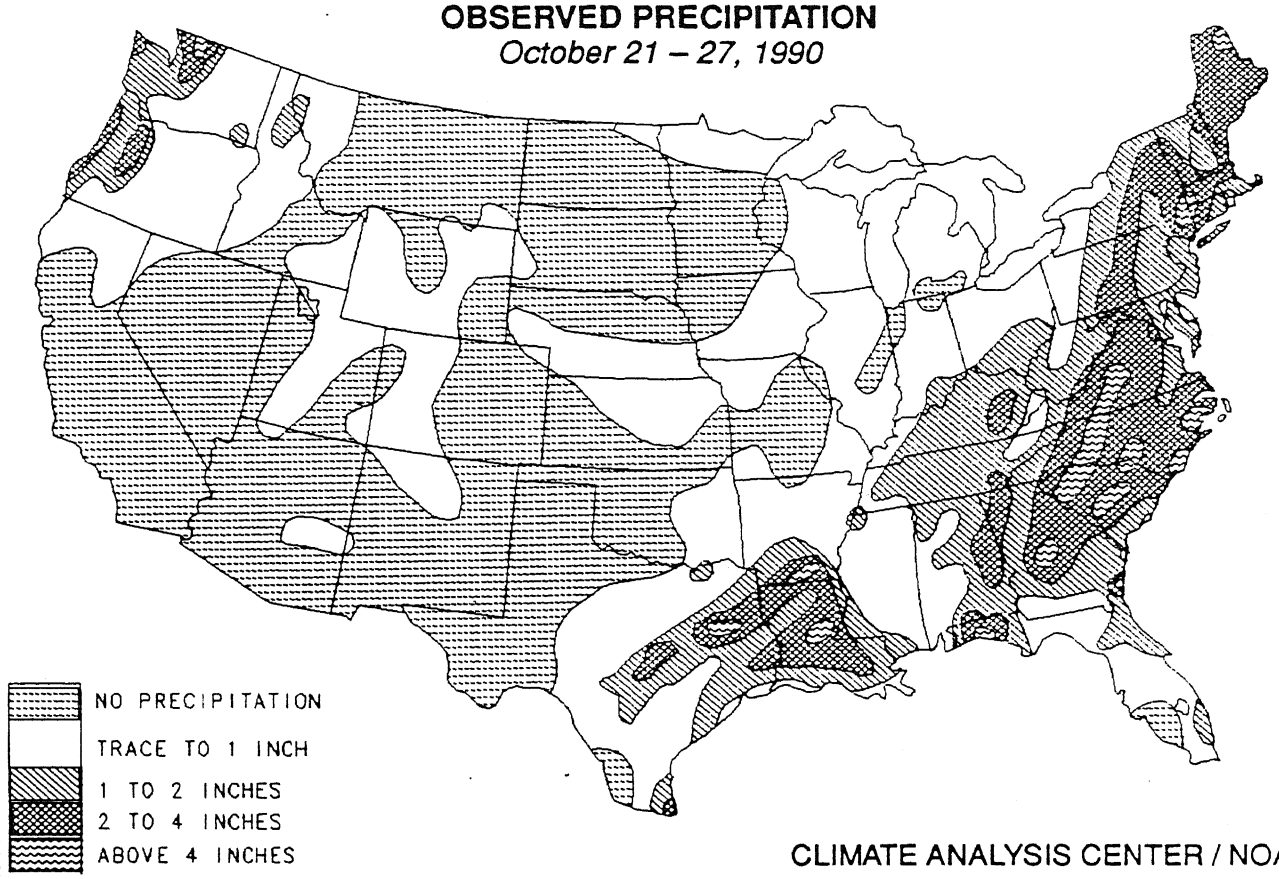
In sharp contrast, conditions were unseasonably cold across the South, Midwest, Great Lakes region, and in northern and central Alaska. Temperatures averaged more than 7°F below normal in the southern Great Plains and lower Mississippi Valley (Table 3). A majority of the country experienced sub–freezing readings as cold air over the Rockies and Plains early in the week pushed eastward, eventually dropping temperatures below 32°F throughout much of the Midwest, Tennessee Valley, Appalachians, and Northeast during the latter half of the week.

TABLE 1. Selected stations with 3.25 or more inches of precipitation for the week.

STATION	TOTAL (INCHES)	STATION	TOTAL (INCHES)
CHARLOTTE, NC	5.95	MARTINSBURG, WV	3.87
YAKUTAT, AK	5.87	QUILLAYUTE, WA	3.84
WILMINGTON, NC	4.99	SITKA, AK	3.77
MACON, GA	4.84	MT. WASHINGTON, NH	3.72
SUMTER/SHAW AFB, SC	4.79	GOLDSBORO/SEYMOUR-JOHNSON AFB, NC	3.56
ANNETTE ISLAND, AK	4.58	RALEIGH-DURHAM, NC	3.44
VALPARAISO/EGLIN AFB, FL	4.48	FAYETTEVILLE/POPE AFB, NC	3.42
COLUMBIA, SC	4.19	LYNCHBURG, VA	3.40
NEW BERN, NC	4.18	MACON/WARNER-ROBINS AFB, GA	3.39
LIMESTONE/LORING AFB, ME	4.15	CARIBOU, ME	3.39
GREENSBORO, NC	4.05	NORTH BEND, OR	3.26

OBSERVED PRECIPITATION

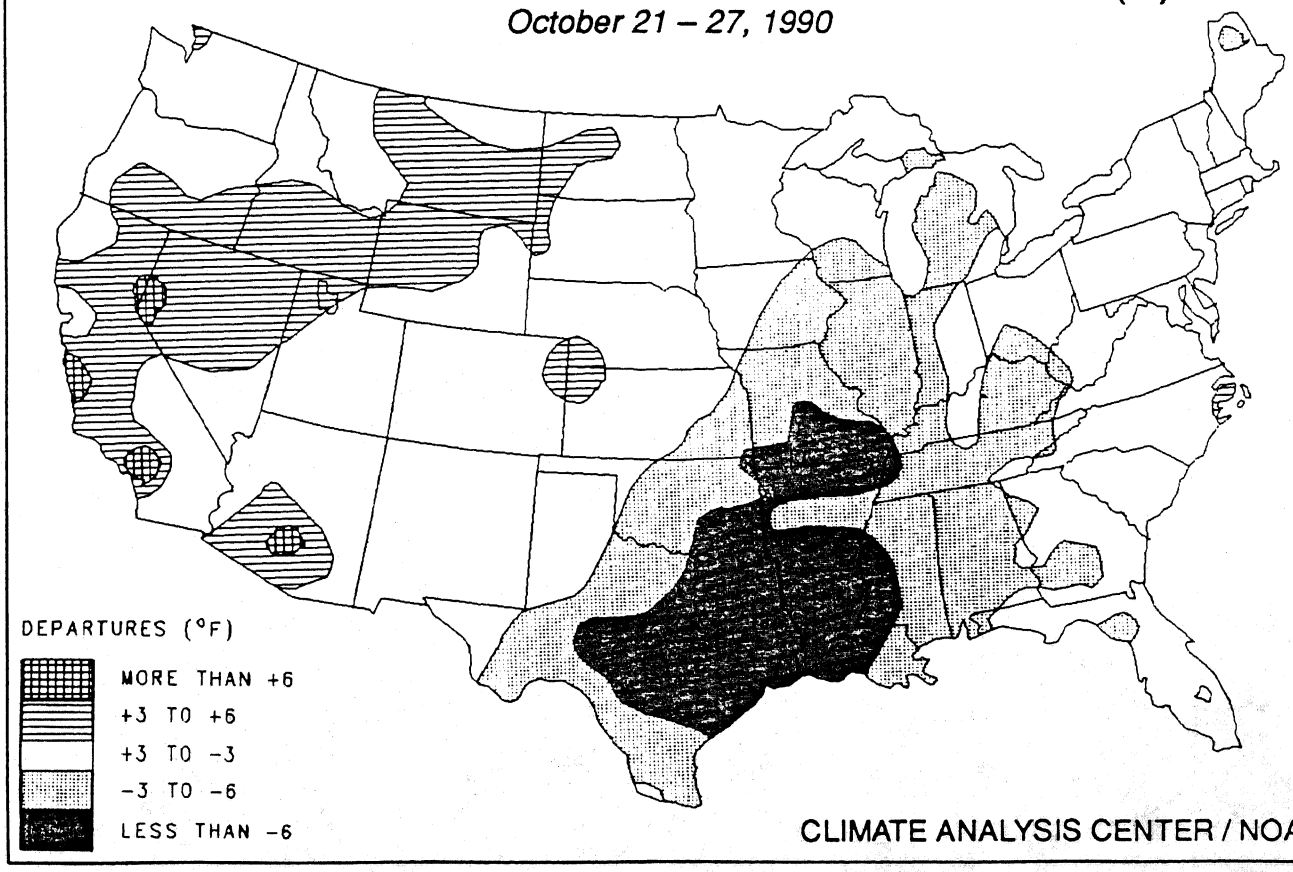
October 21 – 27, 1990



CLIMATE ANALYSIS CENTER / NOAA

DEPARTURE OF AVERAGE TEMPERATURE FROM NORMAL (°F)

October 21 – 27, 1990



CLIMATE ANALYSIS CENTER / NOAA

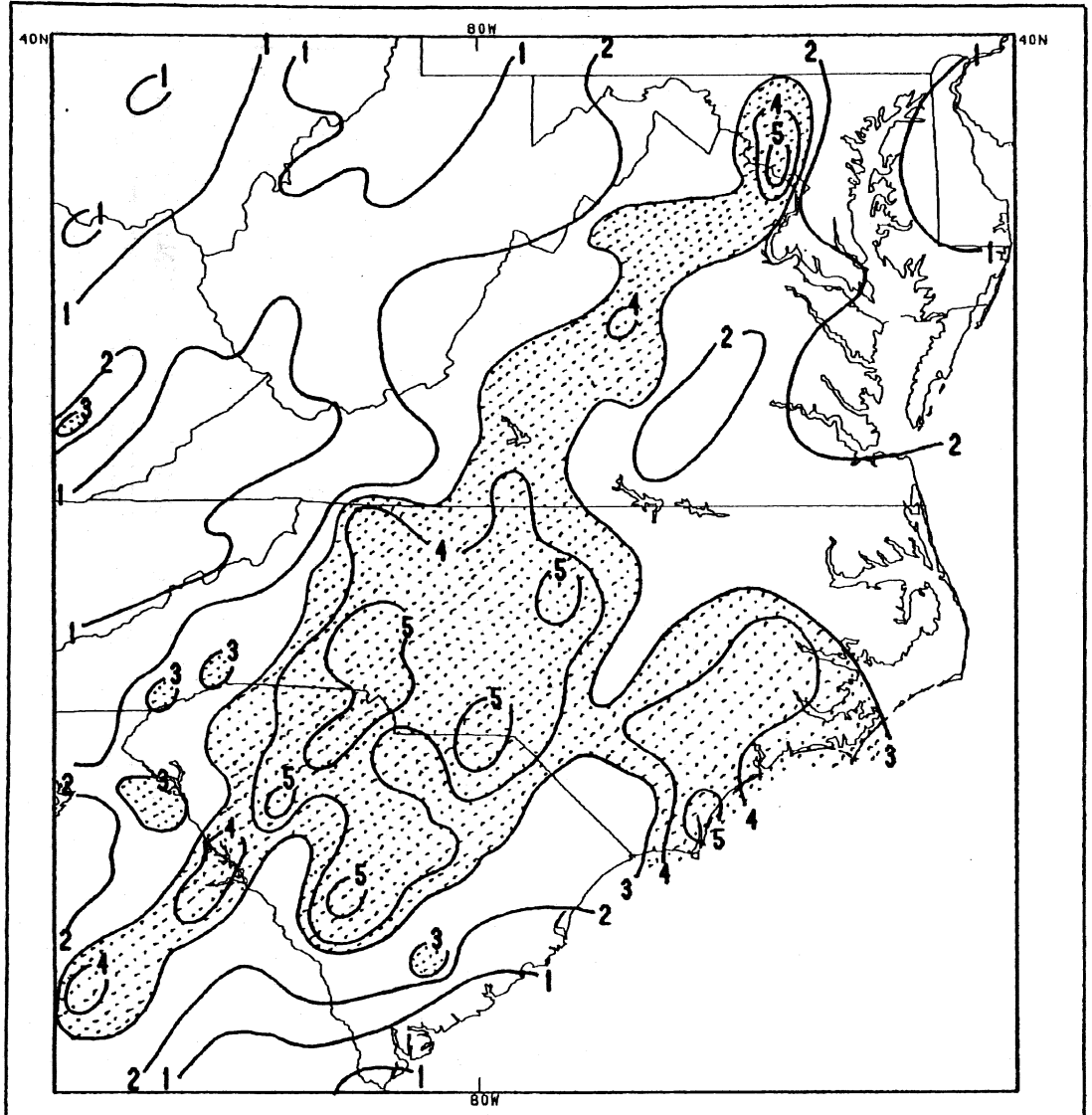


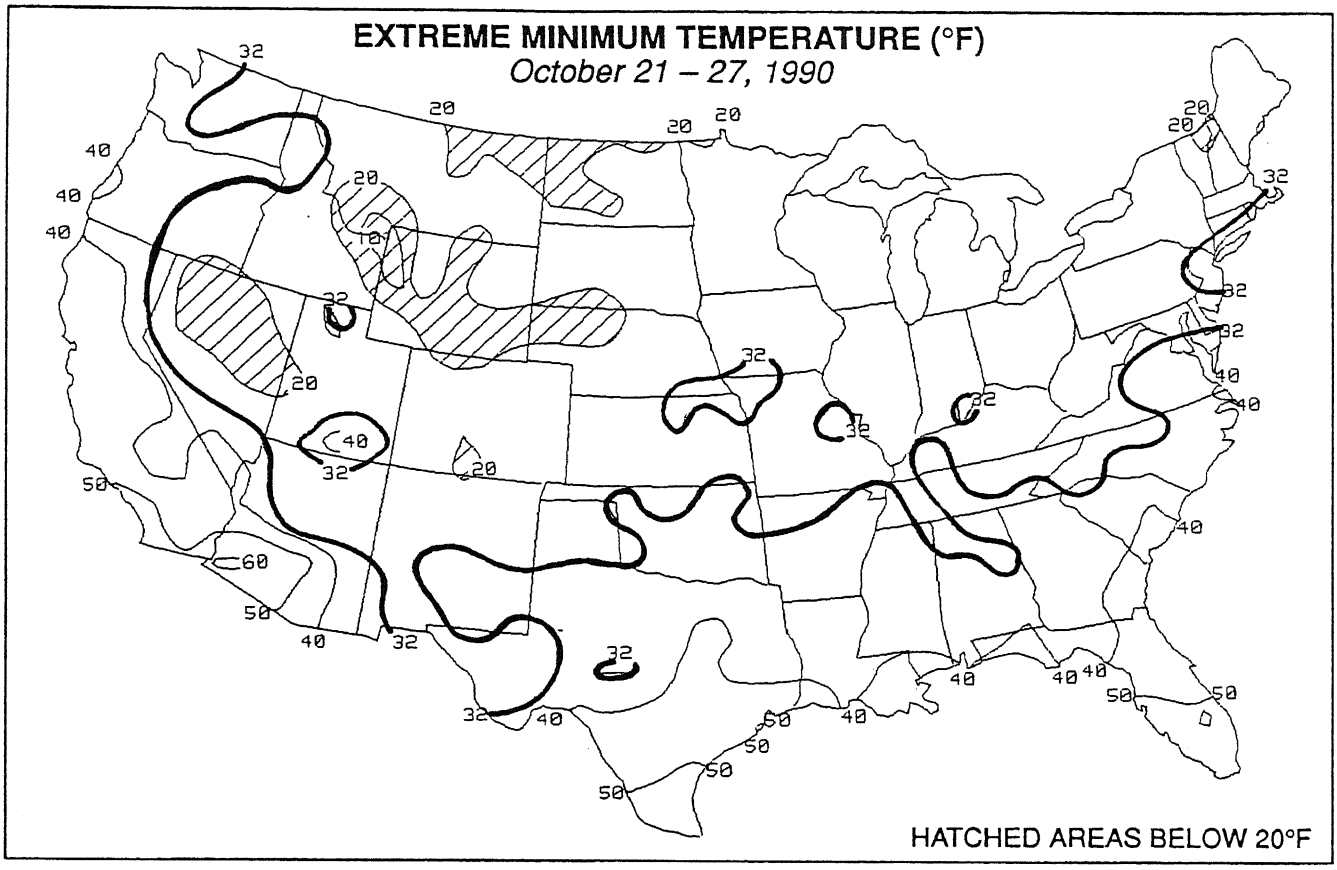
Figure 1. Total precipitation (inches) during the week of October 21-27, 1990 based upon first-order synoptic, airways, and the River Forecast Centers stations. Isohyets are drawn for every inch between 1 and 5 inches, and stippled areas are more than 3 inches. During 2 of the past 3 weeks, heavy rains have soaked portions of the southern and middle Atlantic Coast states, especially eastern Georgia, the central Carolinas, and south-central Virginia. This week's copious rains (up to 6.1 inches) produced additional flooding in parts of the Carolinas and Virginia, but eased long-term dryness in eastern North Carolina.

TABLE 2. Selected stations with temperatures averaging 4.5°F or more ABOVE normal for the week.

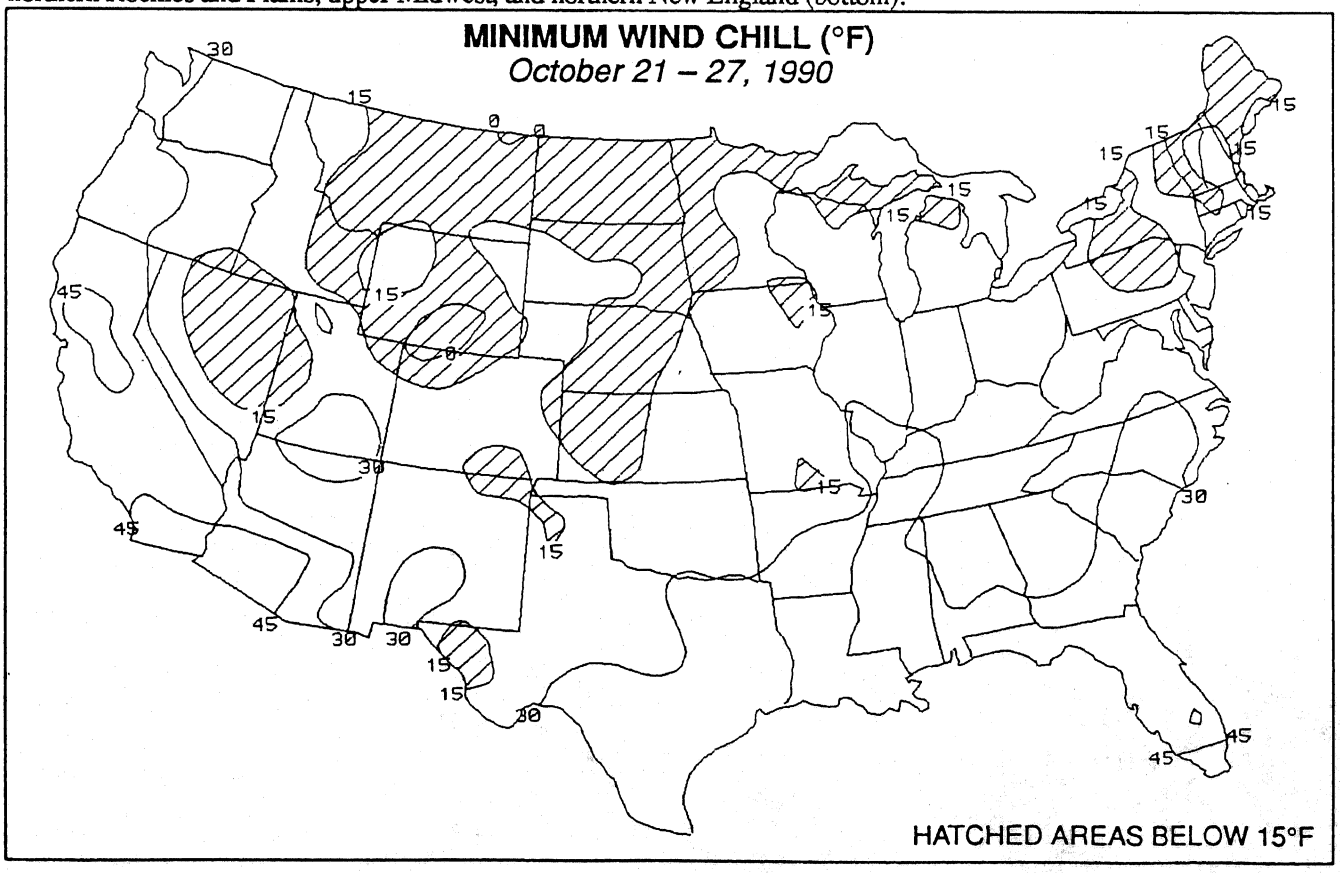
STATION	DEPARTURE (°F)	AVERAGE (°F)	STATION	DEPARTURE (°F)	AVERAGE (°F)
PUNTA PIEDRAS BLANCAS, CA	+10.0	66.0	GLENDALE/LUKE AFB, AZ	+5.1	72.5
RENO, NV	+8.1	55.4	LONG BEACH, CA	+5.0	71.5
SAN BERNARDINO/NORTON AFB,CA	+7.5	70.8	RED BLUFF, CA	+4.8	66.9
VICTORVILLE/GEORGE AFB, CA	+7.2	65.1	BELLINGHAM, WA	+4.8	53.0
LEWISTON, ID	+7.1	55.6	YUMA, AZ	+4.7	77.7
BLUE CANYON, CA	+6.8	58.4	STOCKTON, CA	+4.7	66.2
PHOENIX, AZ	+6.4	76.4	ELY, NV	+4.7	47.6
LOS ANGELES, CA	+5.7	71.0	VALDEZ, AK	+4.7	39.4
DEVIL'S LAKE, ND	+5.7	44.9	TUCSON/DAVIS-MONTHAN AFB, AZ	+4.6	70.6
WINNEMUCCA, NV	+5.5	51.3	LEWISTOWN, MT	+4.6	46.9
BURLEY, ID	+5.5	51.0	GOODLAND, KS	+4.5	53.4
PASO ROBLES, CA	+5.4	65.0			

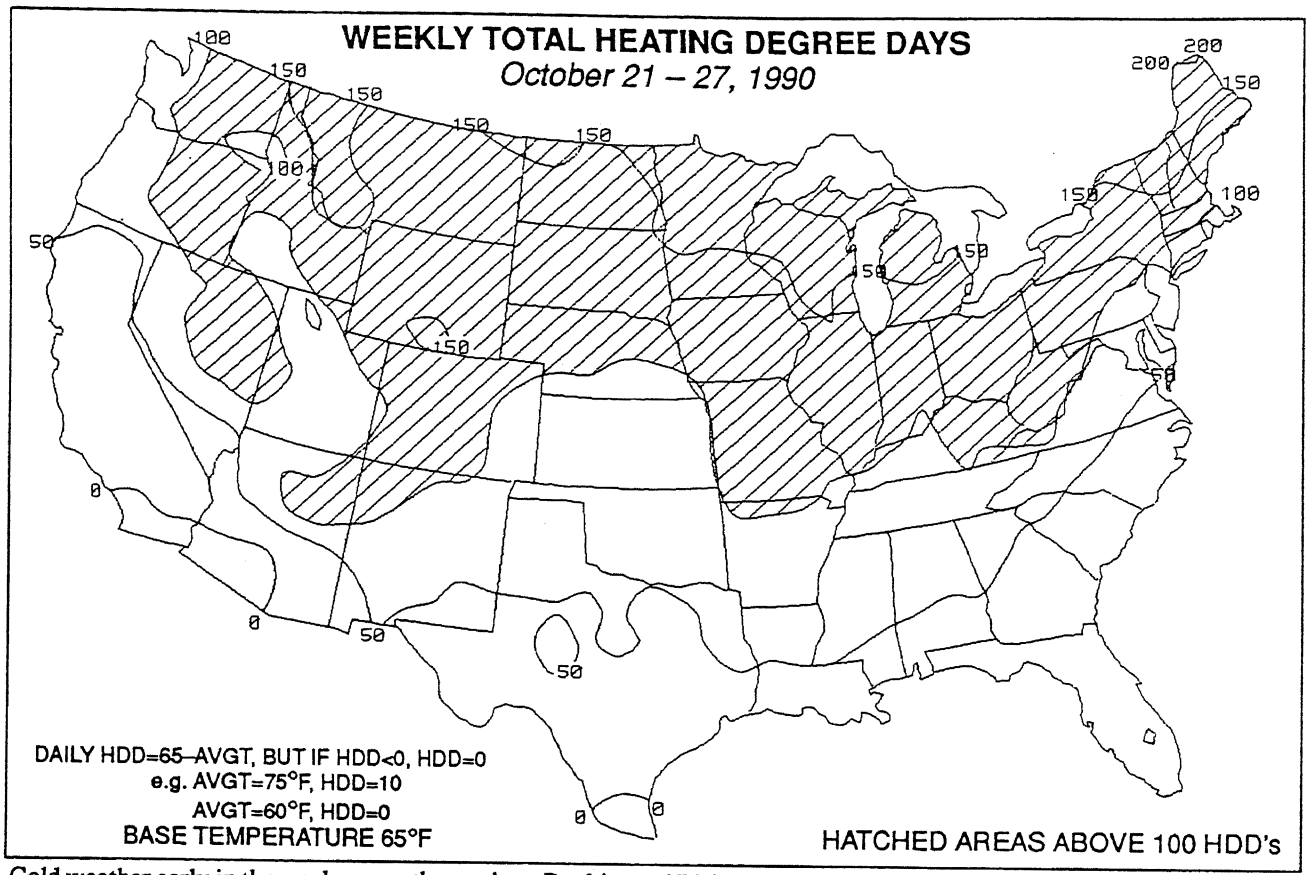
TABLE 3. Selected stations with temperatures averaging 6.0°F or more BELOW normal for the week.

STATION	DEPARTURE (°F)	AVERAGE (°F)	STATION	DEPARTURE (°F)	AVERAGE (°F)
LUFKIN, TX	-8.7	56.6	GALVESTON, TX	-6.9	63.4
WEST PLAINS, MO	-8.6	45.9	FAYETTEVILLE, AR	-6.8	48.7
HOUSTON, TX	-7.8	60.0	LAFAYETTE, LA	-6.8	59.3
BLYTHEVILLE AFB, AR	-7.6	52.3	COLLEGE STATION, TX	-6.8	59.8
PORT ARTHUR, TX	-7.6	59.7	SAN ANTONIO, TX	-6.8	60.7
TEXARKANA, AR	-7.5	55.3	PINE BLUFF, AR	-6.7	54.8
SAN ANGELO, TX	-7.3	56.1	DALLAS-FORT WORTH, TX	-6.7	57.6
SHREVEPORT, LA	-7.3	56.4	HARRISON, AR	-6.6	50.0
MCALESTER, OK	-7.2	52.7	ALEXANDRIA/ENGLAND AFB, LA	-6.6	57.9
AUSTIN/BERGSTROM AFB, TX	-7.2	60.2	BATON ROUGE, LA	-6.5	59.0
EL DORADO, AR	-7.1	53.7	JOPLIN, MO	-6.4	50.4
POPLAR BLUFF, MO	-7.0	50.1	JONESBORO, AR	-6.3	53.3
JACKSON, MS	-7.0	54.9	ANIAK, AK	-6.2	19.8
PALACIOS, TX	-7.0	62.0	GREENWOOD, MS	-6.0	54.9
VICTORIA, TX	-7.0	62.4	MONROE, LA	-6.0	56.1
WACO, TX	-6.9	58.8	LAKE CHARLES, LA	-6.0	60.5

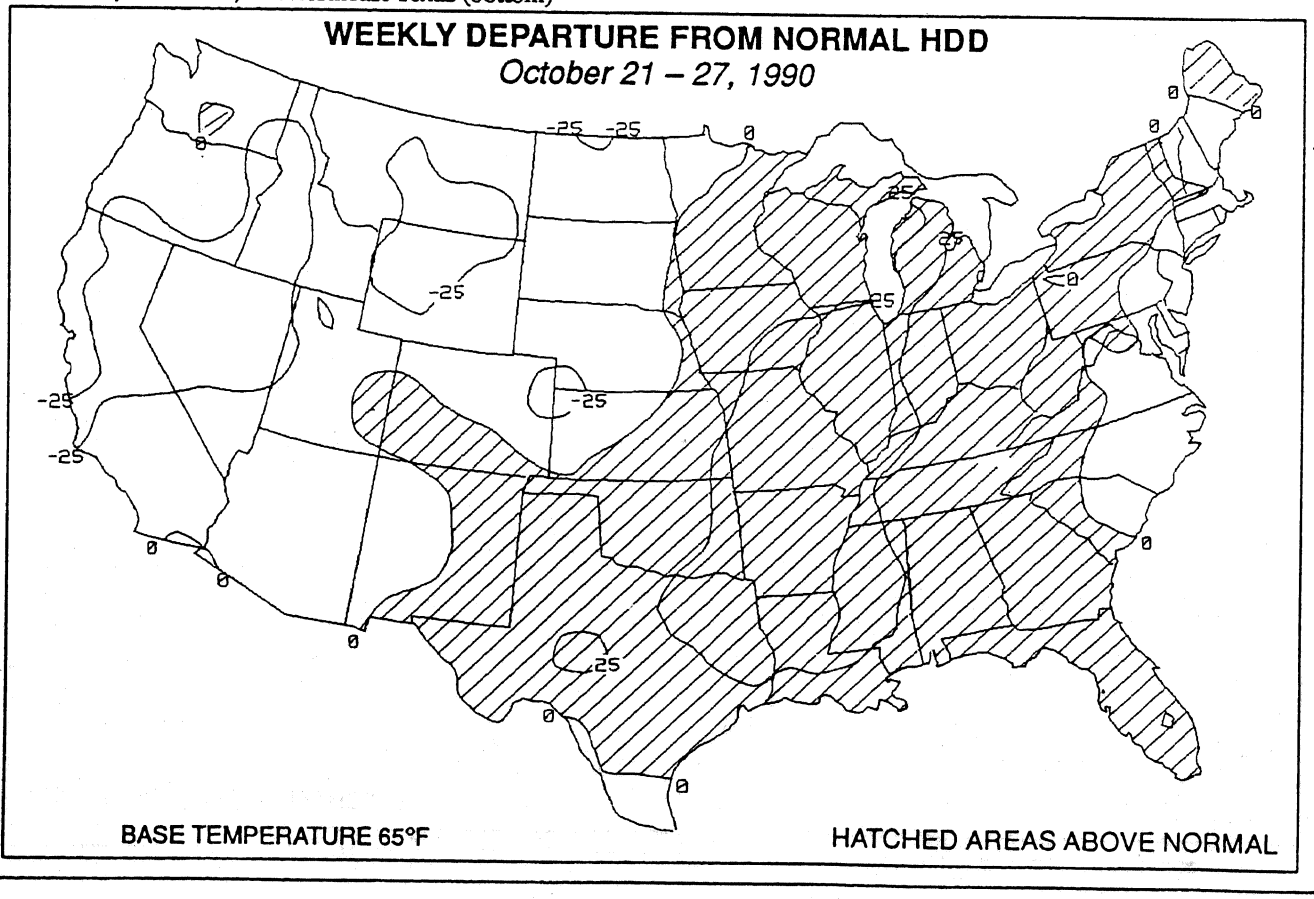


Early in the week, unseasonably cold conditions covered much of the Rockies and Plains, dropping temperatures below freezing. As the cold air pushed eastward by the week's end, most locations in the Midwest, Tennessee Valley, and New England recorded sub–freezing readings (top). Strong winds and low temperatures created very cold wind chills (<15°F) across the northern Rockies and Plains, upper Midwest, and northern New England (bottom).



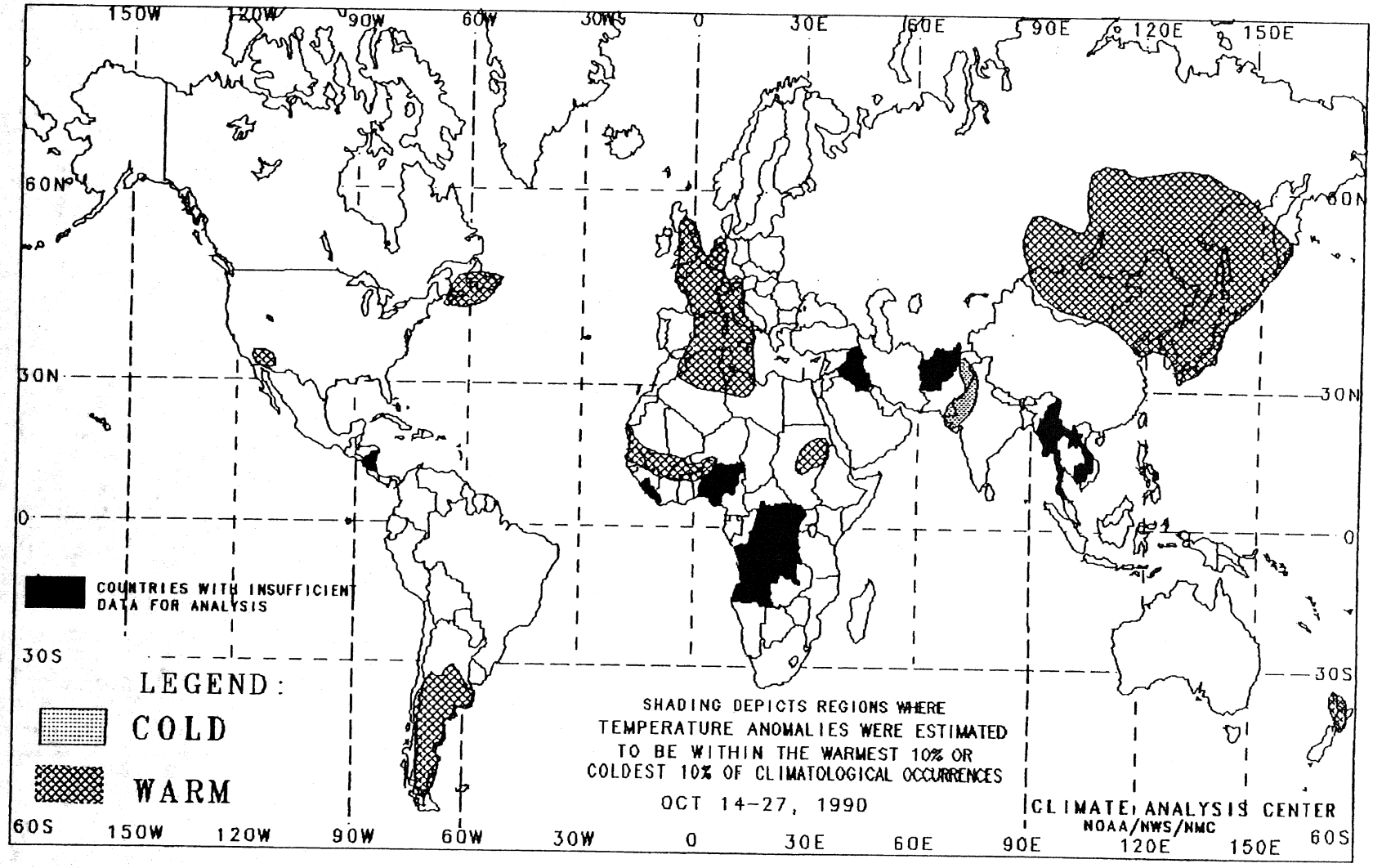


Cold weather early in the week across the northern Rockies and Plains, along with persistently low temperatures throughout the week in the Midwest produced significant heating usage (>100 HDD's) in both areas (top). Subnormal temperatures throughout the lower and middle Mississippi Valley required up to twice the normal weekly heating demand, particularly in Arkansas, Louisiana, and northeast Texas (bottom)



GLOBAL TEMPERATURE ANOMALIES

2 WEEKS



The anomalies on this chart are based on approximately 2500 observing stations for which at least 13 days of temperature observations were received from synoptic reports. Many stations do not operate on a twenty-four hour basis so many night time observations are not taken. As a result of these missing observations the estimated minimum temperature may have a warm bias. This in turn may have resulted in an overestimation of the extent of some warm anomalies.

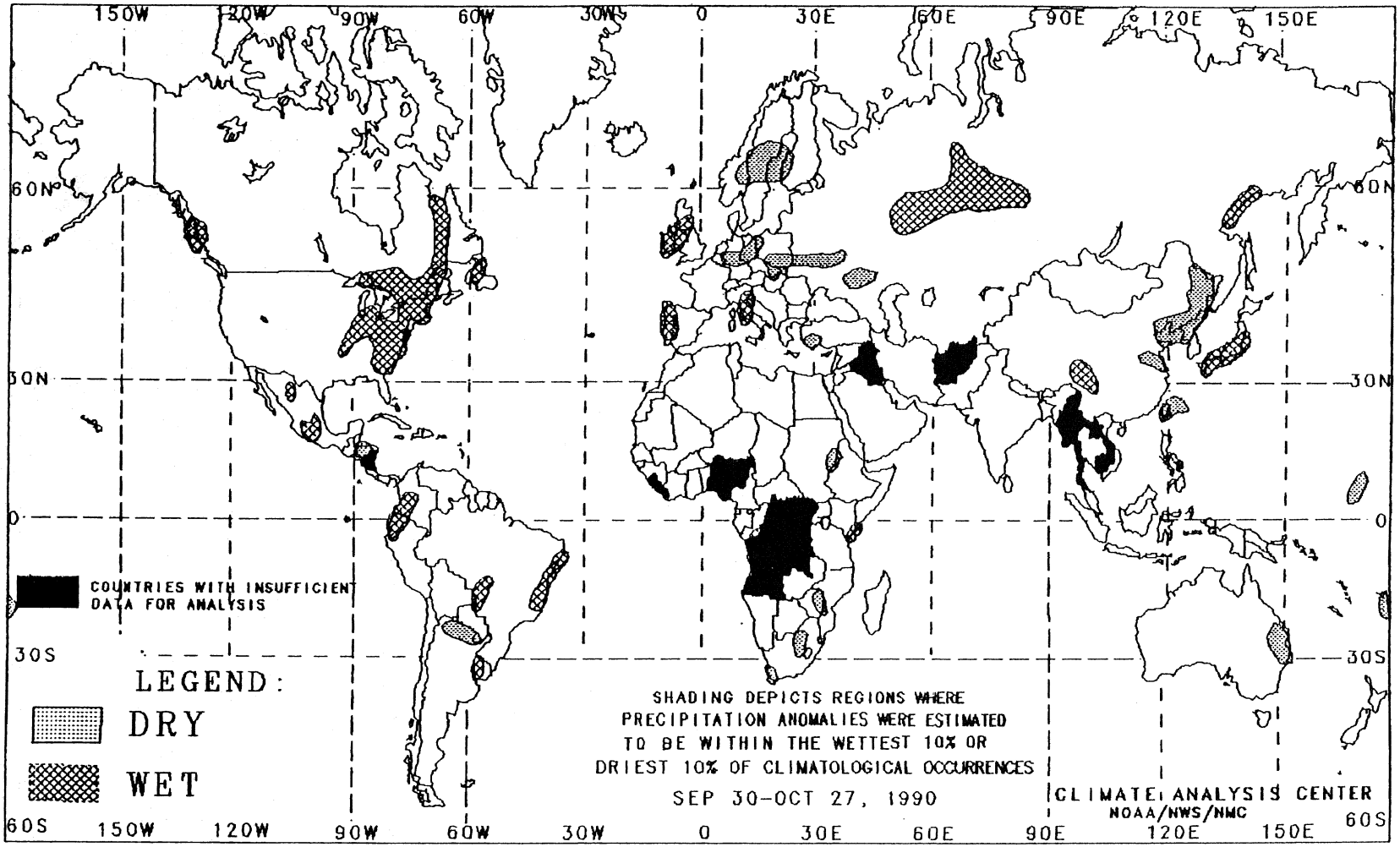
Temperature anomalies are not depicted unless the magnitude of temperature departures from normal exceeds 1.5°C.

In some regions, insufficient data exist to determine the magnitude of anomalies. These regions are located in parts of tropical Africa, southwestern Asia, interior equatorial South America, and along the Arctic Coast. Either current data are too sparse or incomplete for analysis, or historical data are insufficient for determining percentiles, or both. No attempt has been made to estimate the magnitude of anomalies in such regions.

This chart shows general areas of two week temperature anomalies. Caution must be used in relating it to local conditions, especially in mountainous regions.

GLOBAL PRECIPITATION ANOMALIES

4 WEEKS

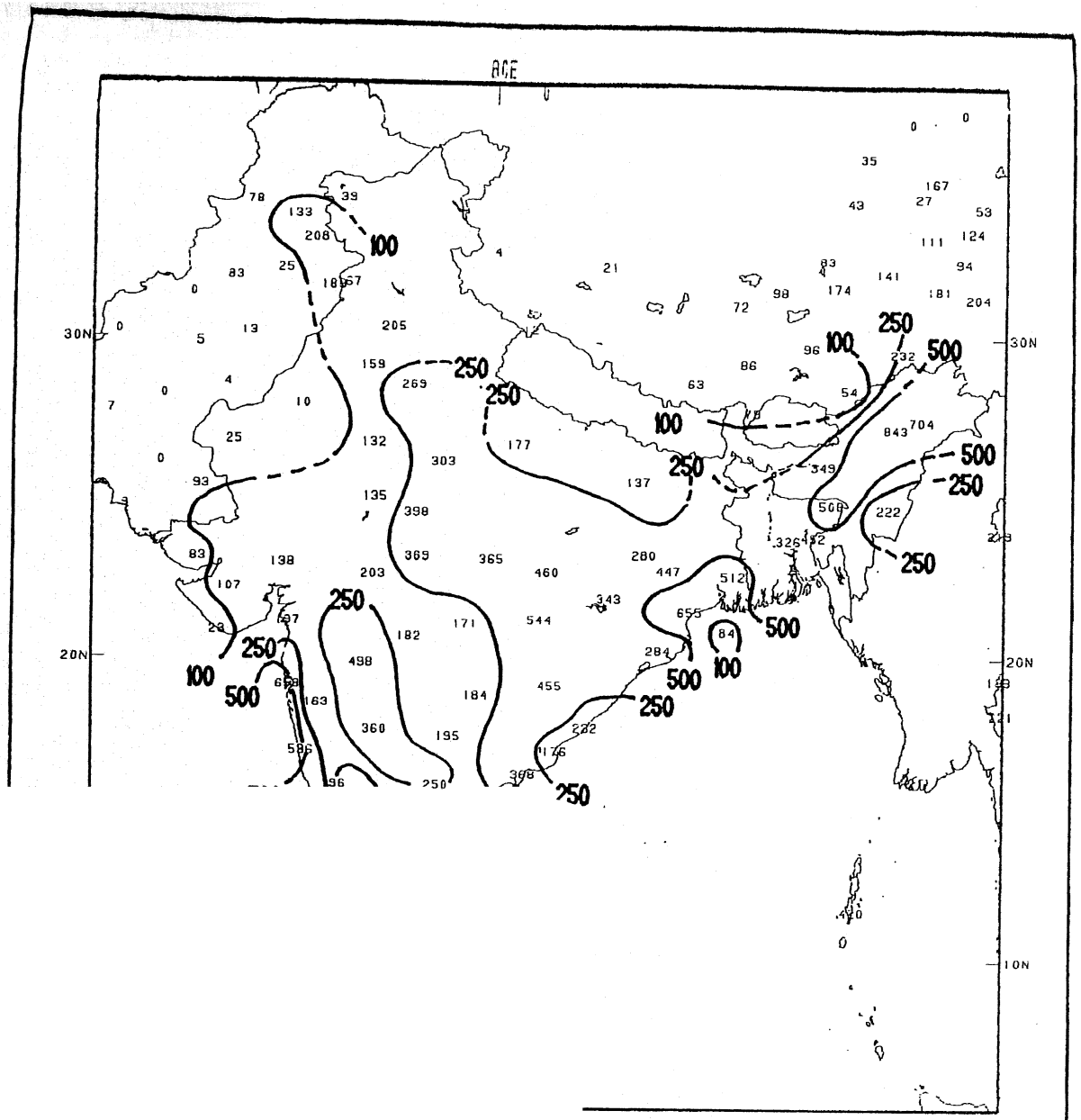


The anomalies on this chart are based on approximately 2500 observing stations for which at least 27 days of precipitation observations (including zero amounts) were received or estimated from synoptic reports. As a result of both missing observations and the use of estimates from synoptic reports (which are conservative), a dry bias in the total precipitation amount may exist for some stations used in this analysis. This in turn may have resulted in an overestimation of the extent of some dry anomalies.

In climatologically arid regions where normal precipitation for the four week period is less than 20 mm, dry anomalies are not depicted. Additionally, wet anomalies for such arid regions are not depicted unless the total four week precipitation exceeds 50 mm.

In some regions, insufficient data exist to determine the magnitude of anomalies. These regions are located in parts of tropical Africa, southwestern Asia, interior equatorial South America, and along the Arctic Coast. Either current data are too sparse or incomplete for analysis, or historical data are insufficient for determining percentiles, or both. No attempt has been made to estimate the magnitude of anomalies in such regions.

The chart shows general areas of four week precipitation anomalies. Caution must be used in relating it to local conditions, especially in mountainous regions.



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SPECIAL CLIMATE SUMMARY

ANALYSIS AND INFORMATION BRANCH
CLIMATE ANALYSIS CENTER, NMC
NATIONAL WEATHER SERVICE, NOAA

REVIEW OF THE 1990 INDIAN MONSOON SEASON

Since the last update of the 1990 Indian monsoon season [through August] (see WCB#90/35 dated Sep. 1, pages 9–11), heavy early September rains fell on north–central Pakistan and northern India before the monsoon withdrew from the region approximately on schedule (see WCB#90/35 page 9 for mean dates and positions). During the remainder of the month, the monsoon continued its slow southeastward retreat, leaving the aforementioned areas seasonably dry but dumping copious rains on southern, central, and northeastern India and much of Bangladesh. According to press reports, the heavy rains caused the Jamuna River to overflow its banks in Bangladesh, displacing at least a million people, washing away dozens of villages, damaging large tracts of crops, and claiming several lives.

By early October, the monsoon had withdrawn to its normal position across central India while ample rains continued in southeastern India. Around mid–October, additional heavy rains inundated northeast India's Assam and Meghalaya states, killing over 100 people due to either water–borne stomach diseases, drownings, or landslides. More than a million people were displaced by the floods in both states. Meanwhile, a strong storm off the Bangladesh coast produced strong winds and heavy rains that briefly submerged Hatia, Sandwip, and Urir Char islands. Bangladesh newspapers said that dozens of fishermen were killed and some 500 boats with 5,000 aboard were missing after the storm. Fortunately, the monsoon retreated on schedule in Bangladesh and northeastern India during late October, but torrential downpours deluged southern India and Sri Lanka. The Press Trust of India reported that at least 44 people were killed in the hills of southern India. Large areas of Coimbatore in Tamil Nadu state were without water because of damaged pipes and a breached water tunnel

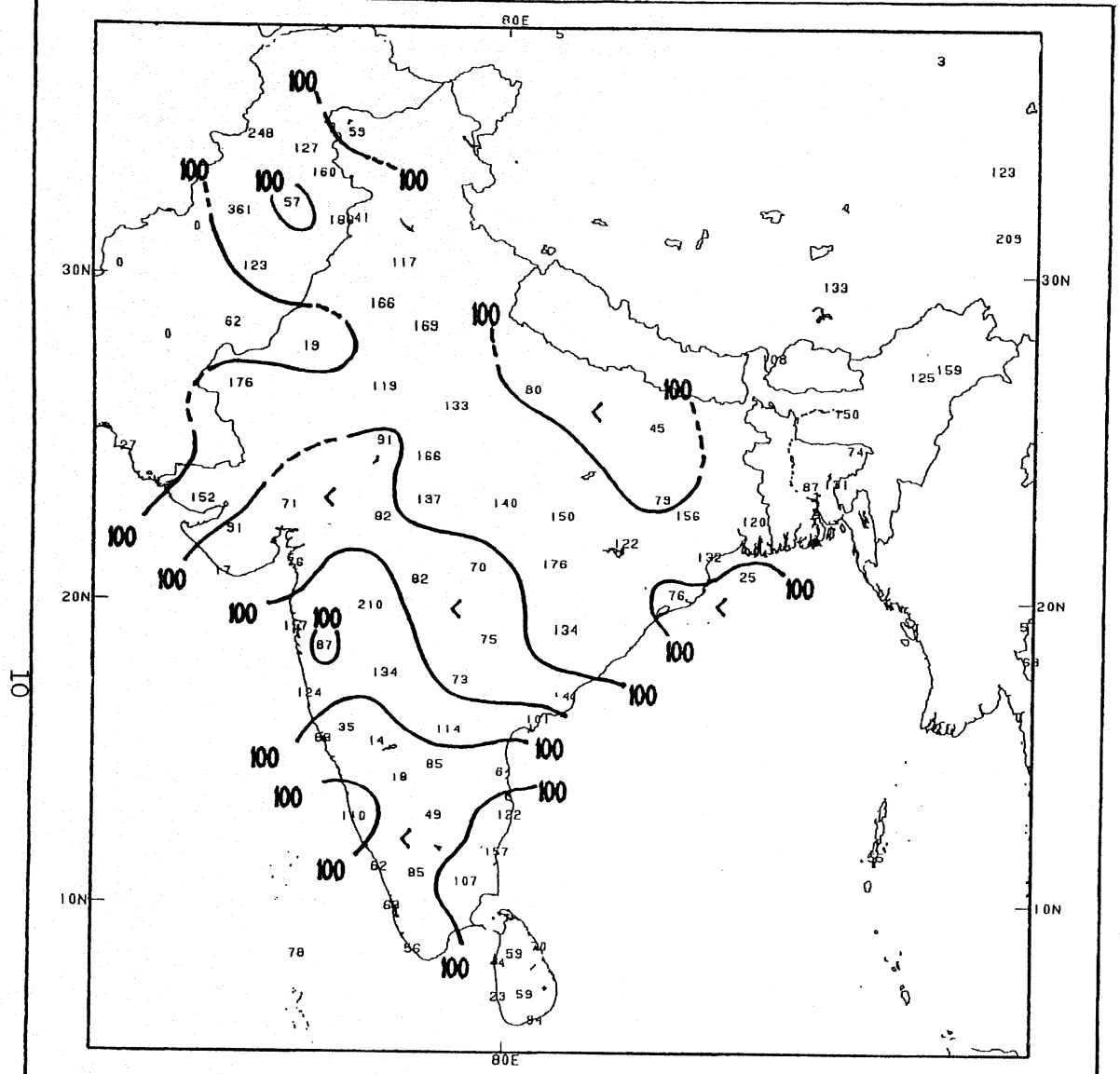

Figure 2. Percent of normal precipitation during **September 1 - October 27, 1990** (57 days). Stations required at least 45 days (80%) for inclusion, and isopleths are only drawn for 100%. There was insufficient data for Nepal, Bhutan, Afghanistan, and Burma, and Bangladesh data are underestimated. The last 8 weeks were abnormally wet in approximately the same areas as the seasonal map [Figure 2] with the exception of above normal rains in extreme west-central and extreme southern India. Subnormal rains continued in parts of southern and central India and southern Pakistan, while Sep.-Oct. rains were much less than earlier in the season across portions of Uttar Pradesh and Bihar.

The 1990 Indian monsoon season is summarized in Figures 3 (total precipitation) and 4 (percent of normal precipitation). Overall, most of central Pakistan, northern, central, and eastern India, and Bangladesh recorded near to above normal monsoonal rains. Areas with significantly below normal seasonal rains included extreme southern (Tamil Nadu, Kerala, and eastern Karnataka states) and extreme western India (western Gujarat and Rajasthan states) and southeastern Pakistan.

This year's monsoon started near to slightly ahead of schedule, and was preceded by an intense cyclone during early May (see WCB#90/19 dated May 12). The cyclone, thought to be the most severe in over a decade in India, battered the southeastern Indian coast of Andhra Pradesh state. Even though advanced warnings and evacuations saved untold lives, the death toll surpassed 1,000.

Heavy June rains in northwestern, southwestern, and eastern India and Bangladesh caused severe flooding along downstream rivers. During mid–June, torrential downpours dumped over 560 mm of rain in a 24–hour period on parts of Bombay, with more than 400 mm occurring during one 6–hour span.

In July, additional flooding hit Bangladesh, affecting over 2 million people, while copious rains killed hundreds and displaced a similar number of people in parts of northern, western, and northeastern India.

The rains diminished during early August, but returned later in the month to northeastern India, once again flooding much of northwestern Bangladesh. Farther west, heavy monsoonal rains finally reached western India's Gujarat state, but several river overflowed, causing widespread damage and the loss of dozens of lives. Towards the end of August, downpours in the districts south of Katmandu, Nepal produced flooding and landslides that blocked all roads leading to the capital.

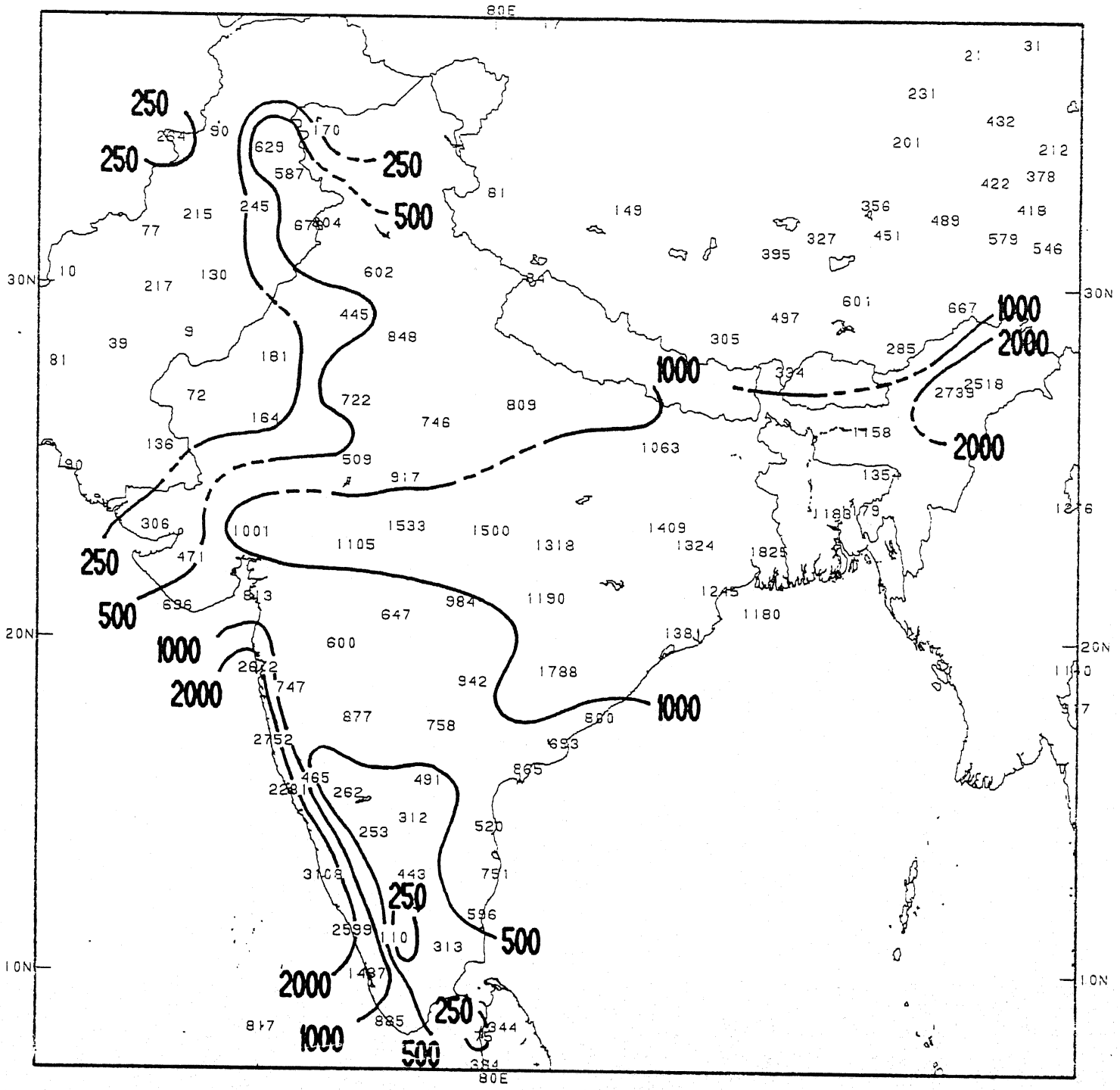

Figure 3. Total precipitation (mm) during May 1 - September 30, 1990 (153 days). Stations required at least 122 days (80%) for inclusion, and isohyets are only drawn for 250, 500, 1000, and 2000 mm. There was insufficient data for Nepal, Bhutan, Afghanistan, and Burma, and rainfall data for Bangladesh were most likely underestimated. Greatest seasonal rainfall amounts occurred in eastern India, Bangladesh, and along the southwestern coast of India as expected. The May-September totals of 500-1500 mm in northwestern and central India were well above normal, but the 250-500 mm across much of extreme southern India was below normal.

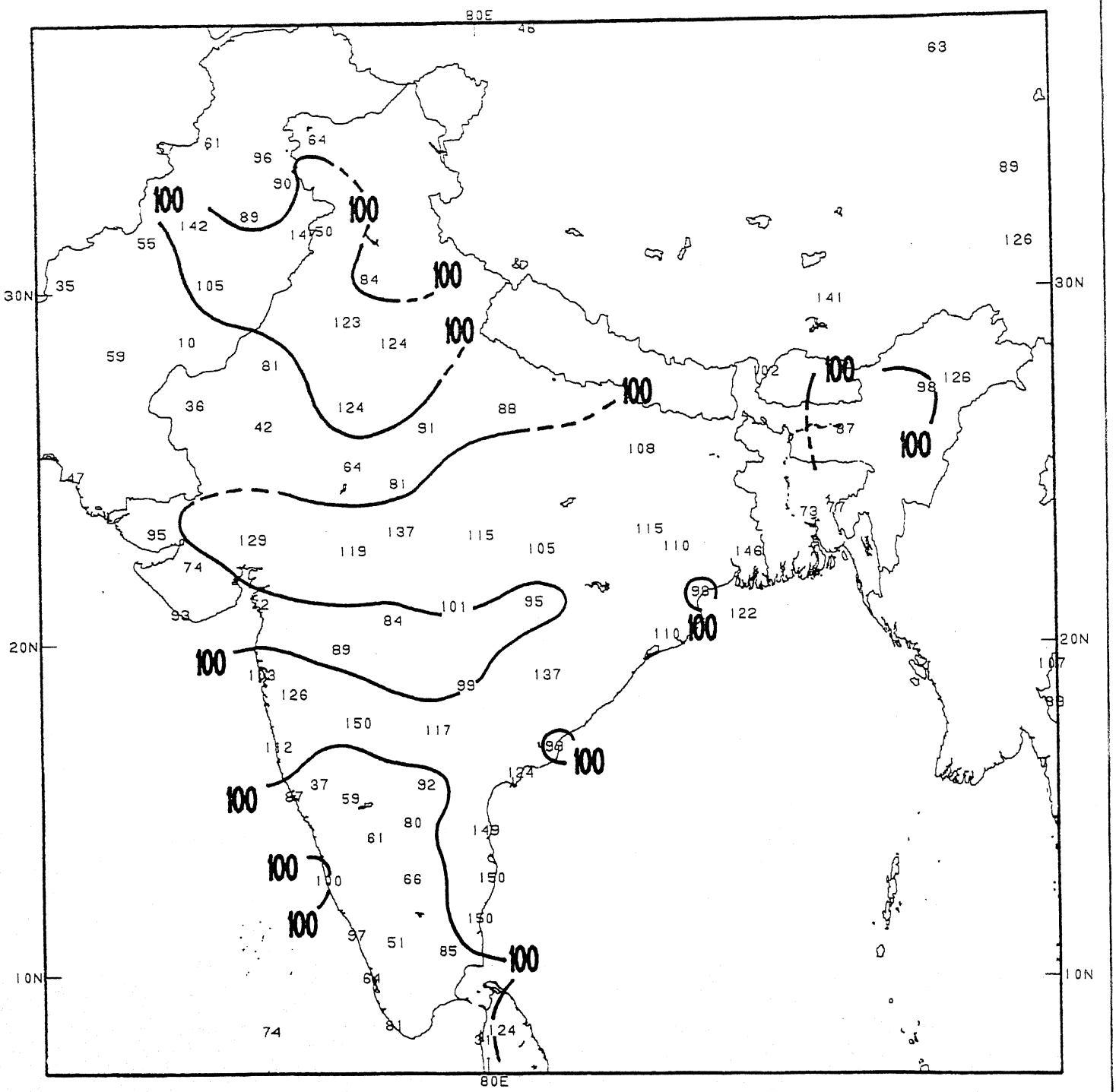

Figure 4. Percent of normal precipitation during May 1 - September 30, 1990 (153 days). Stations required at least 122 days (80%) for inclusion, and isopleths were only drawn for 100%. There was insufficient data for Nepal, Bhutan, Afghanistan, and Burma, and percentages for Bangladesh are most likely underestimated. Above normal seasonal rains were observed across most of east-central Pakistan, northwestern, central, and eastern India, and most likely Bangladesh. In contrast, subnormal monsoonal rains fell on much of extreme southern and extreme west-central India, southern Pakistan, and on a few areas of central and northeastern India.

SPECIAL CLIMATE SUMMARY

ANALYSIS AND INFORMATION BRANCH
CLIMATE ANALYSIS CENTER
NATIONAL WEATHER SERVICE, NOAA

REVIEW OF THE 1990 AFRICAN SAHEL RAINY SEASON

The primarily dry, hot, and short 1990 African Sahel rainy season (May 1 — September 30) bore little resemblance to the cooler and more favorably moist seasons of 1989 and 1988. In 1990, very few locations reported above normal precipitation, and exceptionally dry weather (less than 60% of normal rainfall) dominated the northern, extreme western, and much of the eastern Sahel. The adverse affects of the dryness were exacerbated by unusually high temperatures during July — September in most areas.

The rainy season got off to a slow start in May. Adequate rains moistened Burkina Faso, Niger, southern Mali, southern Chad, and southwestern Sudan, but most areas measured slightly below normal rainfall during the month. Exceptional dryness plagued Senegal, Gambia, and central Sudan, where under half the normal rains were recorded. In sharp contrast, isolated rainfall episodes generated flash flooding and took dozens of lives in southern Nigeria and the Ethiopian highlands.

During June, unusually low rainfall became a severe problem in many areas. Less than half the normal rainfall was again recorded in western Senegal as well as through most of Cote d'Ivoire, northern Ghana and southern Burkina Faso, central and southern portions of Benin and Togo, northeastern Nigeria and southeastern Niger, central Chad, central and southeastern Sudan, and extreme western, northern, and northeastern Ethiopia. Abundant rainfall was restricted to parts of Burkina Faso, Mali, and southwestern Chad, with moderate to heavy rains partially alleviating earlier dryness in eastern Senegal and west–central Ethiopia (see WCB #90/28, dated July 14, pages 13–15, for the May — early July summary).

Moisture conditions generally improved across the western Sahel during July, and heavier rainfall also developed from eastern Chad eastward into central Ethiopia. Unfortunately, dry weather re–developed after a brief respite in northern Senegal, and subnormal July rainfall also afflicted parts of southern Mauritania, Mali, Niger, and eastern Burkina Faso, eastern Sudan, and northern Ethiopia.

Drier weather again enveloped most of the Sahel during August. In western sections, near normal rain was restricted to southern Senegal, southwestern Mali and Burkina Faso, and northern sections of Ghana, Togo, and Benin. Most other locations reported less than 75% of the August normal. High temperatures and excessively dry weather combined to severely stress crops across northern agricultural areas of the western Sahel. Conditions were even more severe in the eastern Sahel. August departures above +4°C in northern crop areas of Sudan combined with marked dryness to produce irreversible crop damage, according to the Joint Agricultural Weather Facility. Subnormal August rains and high temperatures also plagued central Chad and northern Ethiopia; however, the Ethiopian News Agency reported that downpours flooded several rivers in southwestern Ethiopia's Gambella region, driving more than 300,000 Sudanese and 100,000 Ethiopian individuals from their homes (see WCB #90/35, dated September 1, pages 12–14, for the July — August summary).

September brought near normal rains to most of the Sahel. A few locations in northern Senegal, southern Mali, southwestern Niger, northern Sahelian Sudan, and the northern half of Ethiopia reported heavy rains, with dryness restricted to portions of Burkina Faso. The September rains, however, had little affect on the prevailing moisture deficits, and were partially offset by an increased evaporation rate due to continued above normal temperatures, particularly along the northern tier.

Rainfall totals exceeded 1000 mm in southern Mali, western Guinea, and the Ethiopian highlands, then decreased from south to north (Figures 1 and 3). Near to slightly above normal amounts (between 90% and 122%) were restricted to the Ethiopian highlands, extreme southwestern Niger and eastern Burkina Faso, and extreme southern Mali and southwestern Burkina Faso (front cover, Figure 2). Most locations received 75% to 90% of normal rainfall while several areas, including northern Senegal, southern Mauritania, eastern Chad, west–central and east–central Sudan, and northern Ethiopia, recorded less than half the normal rainfall. The dryness aroused concern in east–central Sudan, where the government requested emergency aid, and across northern Ethiopia, where two consecutive dry rainy seasons have fueled concerns about another famine.

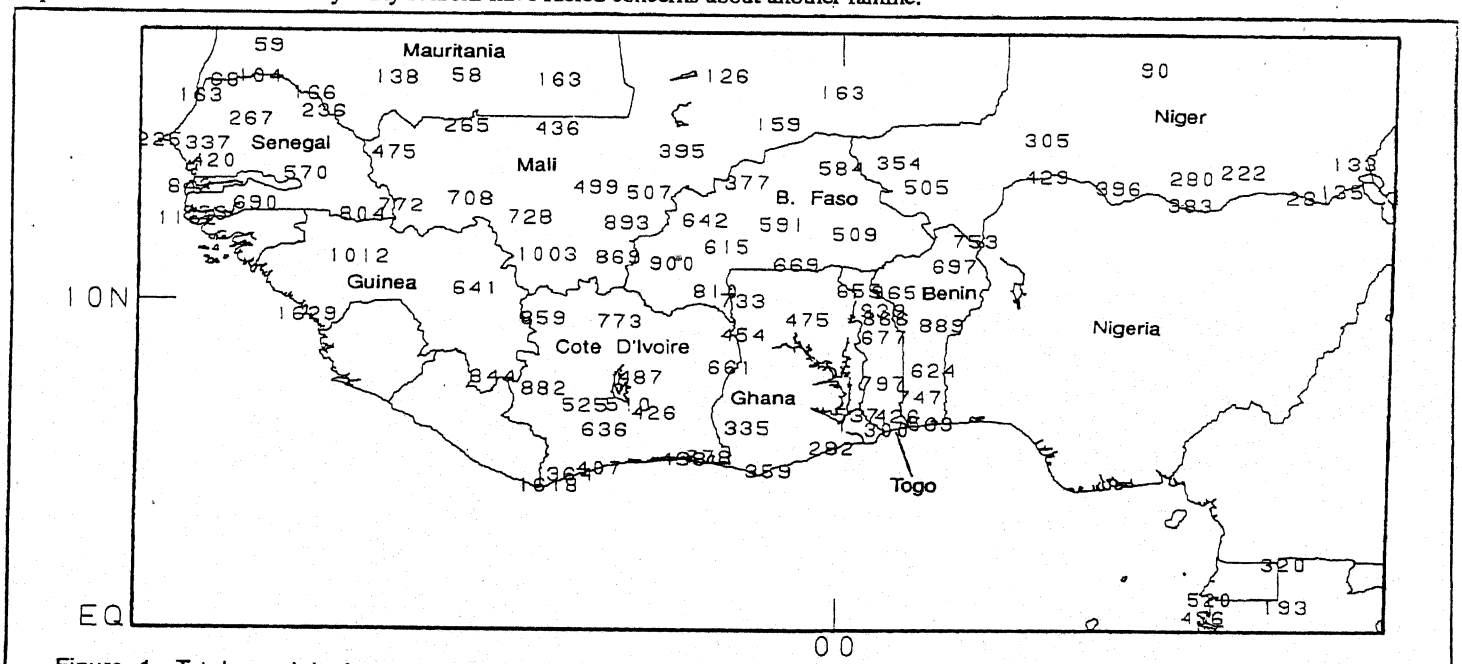

Figure 1. Total precipitation (mm) during May 1 - September 30, 1990 (153 days) for the western African Sahel. Stations required at least 122 days (80%) for inclusion, and isohyets were not drawn due to large areas of missing or incomplete data (e.g. Nigeria, Liberia, Sierra Leone). Seasonal totals generally increased from north to south as expected, with over 800 mm reported in extreme southern Senegal, Guinea, southwestern Mali, western Cote D'Ivoire and Burkina Faso, and central Togo and Benin. Incomplete meteorological and supplemental satellite data, along with news reports, indicated generous rains in Liberia, Sierra Leone, Guinea-Bissau, and the southern half of Nigeria, with possible inadequate rainfall across northern Nigeria.

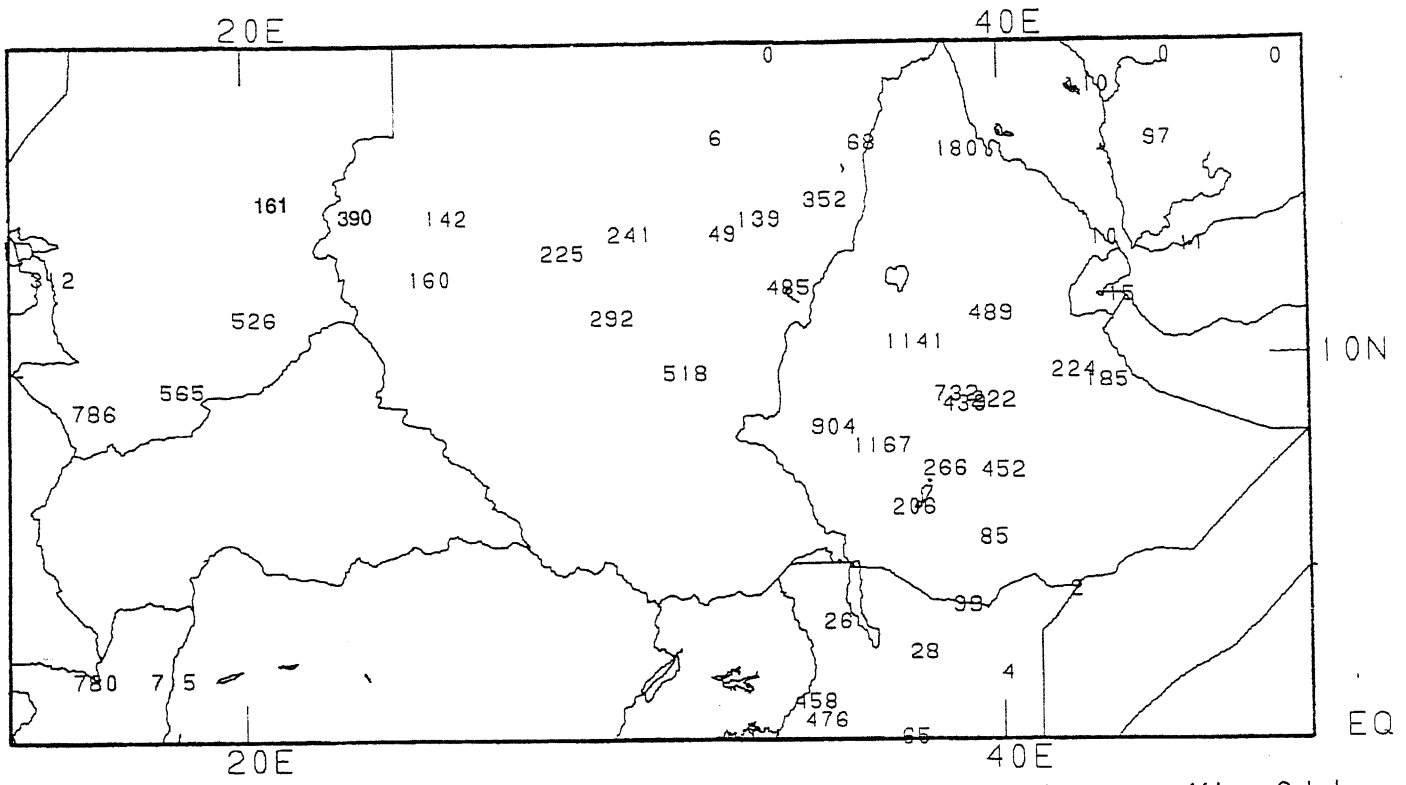

Figure 2. Total precipitation (mm) during May 1 - September 30, 1990 (153 days) for the eastern African Sahel. Stations required at least 122 days (80%) for inclusion, and isohyets were not drawn due to large areas of incomplete data (e.g. southern Sudan, Central African Republic, central Chad). A lack of significant rains across most of central Chad, Sudan, and northern Ethiopia, along with unseasonably hot weather, has caused widespread and severe agricultural damage, especially in east-central Sudan.

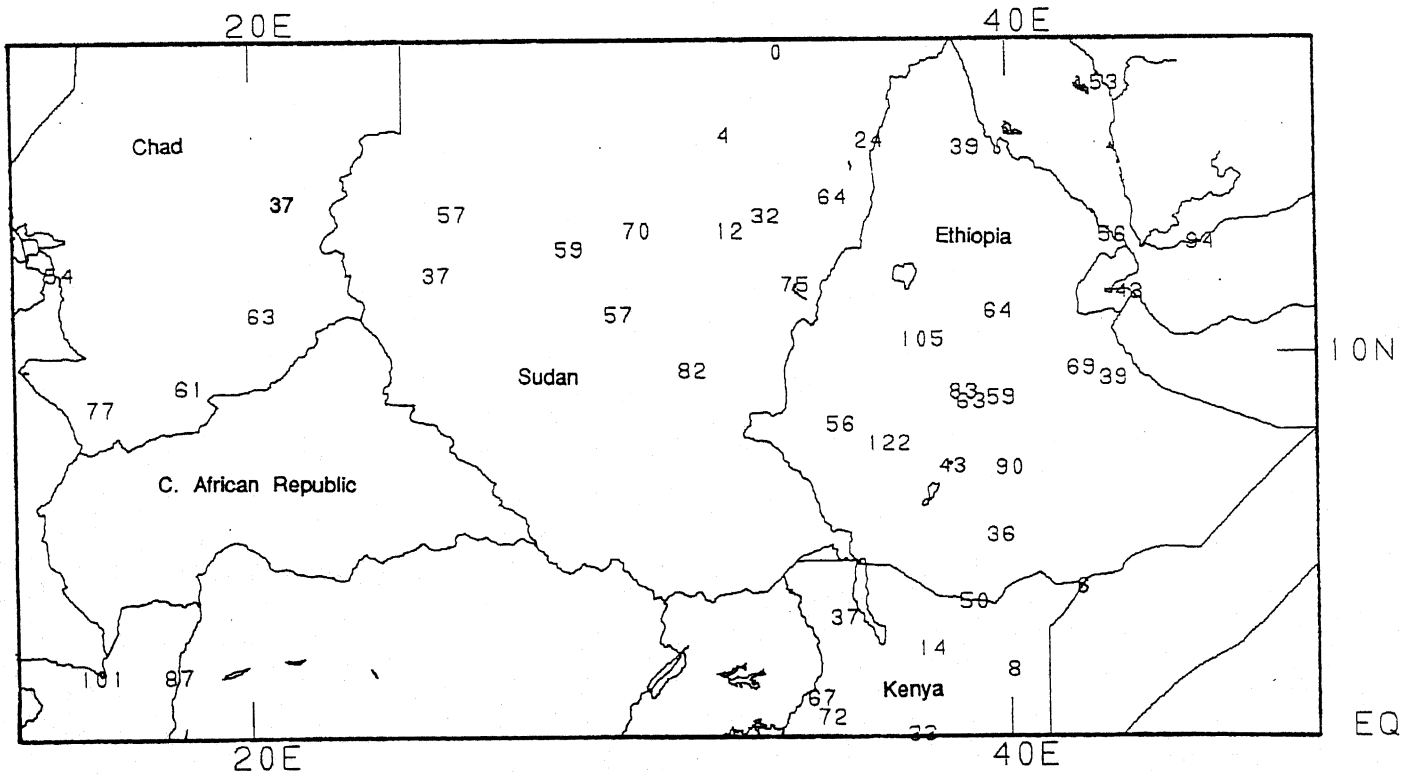

Figure 3. Percent of normal precipitation during May 1 - September 30, 1990 (153 days) for the eastern African Sahel. Stations required at least 122 days (80%) for inclusion, and isopleths were not drawn due to large areas of incomplete data. Most of central Chad, Sudan, and northern Ethiopia received less than two-thirds of the normal seasonal rainfall, with some sections recording well under half the usual rains. Temperature departures of +2°C to +4°C accompanied the dry weather during August in Sudan. In late October, the government of Sudan appealed for immediate food assistance of 75,000 tons, with western aid workers stating that at least 1 million people were under famine threat in the north of the country alone, according to news reports.